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A Note on Wind and Wave Conditions in the Southern Gulf of St. Lawrence*

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The Gulf of St. Lawrence is an enclosed elongate body of water defined by the coasts of Labrador and Newfoundland on the north and northwest and, shorelines of New Brunswick, Prince Edward Island and Cape Breton Island to the south. It has a maximum southwest-northeast extent of 790 km and an east-west extent of 320 km. The Gulf is connected to the Atlantic via two narrow straits - the Strait of Belle Isle to the northwest and Cabot Strait to the east - but the important waves are generated within the Gulf rather than entering from the open ocean via these straits. The rapid erosion of the soft red sandstone cliffs of Prince Edward Island and parts of New Brunswick, and the continual modification of the sand dune and barrier island systems. testify to the effectiveness of these wave systems, which tend to be concentrated on particular stretches of coastline due to wave refraction in the southern part of the Gulf. South of a line joining the Magdalen Islands and the Gaspé peninsula the sea floor shelves rapidly and there is a relatively complicated submarine topography. Because of the size of the Gulf of St. Lawrence, swell, as seen on open ocean coasts, is not such an important factor. The waves are mostly a function of winds produced by storms and low pressure systems passing across the Gulf or along the eastern seaboard of Nova Scotia. An analysis of wind directions and speeds at Summerside, Prince Edward Island, which may be taken as typical, reveals two important wind regimes. The prevalent winds blow from between south and northwest, accounting for 58 per cent of total wind directions, but only 40 per cent of maximum wind speeds for each month. The strongest winds come from between north and east southeast. The significance of this pattern is that the prevalent winds are offshore on the open Gulf sandy coasts of New Brunswick and Prince Edward Island, and that there are many periods when wave action is relatively light. However, the strongest winds, though less frequent, blow over long fetches generating the dominant waves, which are of low frequency but large magnitude.

There are no actual wave records for the southern Gulf of St. Lawrence but a model of wave characteristics has been developed from wind data over a five-year period (Quon, Keyte and Pearson, 1963). A summary of their findings (Table 1) indicates that long wave lengths over 500 ft (152.5 m) are uncommon in the Gulf but that wave heights over 10 ft (3.05 m) do occur quite frequently. The

Table 1 - Summary of Derived Wave Characteristics for the Gulf of St. Lawrence

(For one year, in hours)

Wave Height (ft)	Wave Length (ft) 50	100	150	200	250	300	350	400	450	500	TOTAL
2	19279										19279
4	6545	1320	2412	197	157	74	46	12	30	7	8529
6	518	4177	154	97	66	39	25	2	10	4	5101
8	48	924	606	36	27	16	39	1	7		1704
10	4	542	524	17	18	23	18	4	5	6	1161
12	4	60	457	81	11	2	4	3		7	629
14		12	261	51	6	13	8		4	5	360
16		4	111	111	4						230
18		3	29	95	18						145
20			3	40	30						73
22			3	22	13						38
24			4	13	2						19
26					1						1
28						1					
TOTAL	26398	7042	2393	760	353	167	140	22	65	29	

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waves in the Gulf are, however, characteristically short period waves of low height. The probability of occurrence of waves of different heights and lengths is shown in Figure 1. It should be remembered that the wave characteristics shown in this figure and in Table 1 refer to the open Gulf of St. Lawrence and that wave characteristics inshore on northern Prince Edward Island and along the other southern shores of the Gulf are likely to show the effects of wave refraction and more limited fetches.

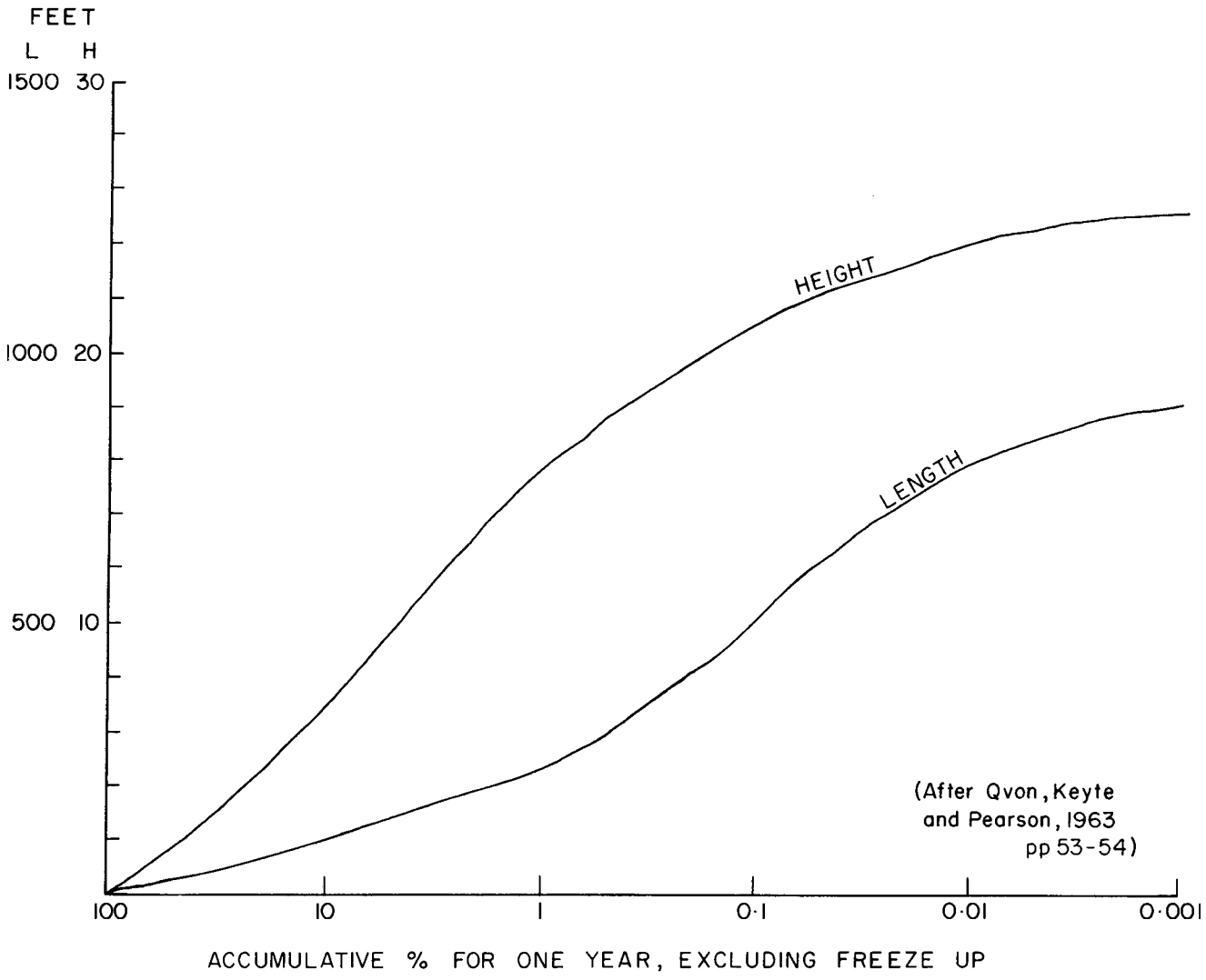

Figure 1 - Probability of occurrence of waves of particular lengths and heights in southern Gulf of St. Lawrence.

Using this derived wave information as a basis, a model of wave refraction patterns was developed for Kouchibouguac Bay, New Brunswick (Bryant, 1972; McCann and Bryant, 1973) and extended to include the whole area between Miscou Island and central Prince Edward Island. This analysis involved the construction of numerous wave refraction diagrams. Because of the shape of the southern Gulf the orthogonals of most waves entering from between north and east tend to diverge, an effect which is emphasized by the submarine trough and ridge system north of Prince Edward Island. This divergence is greatest along the New Brunswick coast, south of Miscou Island, and along the northeastern shore of Prince Edward Island for waves approaching from northerly directions; it is greatest for the northern Northumberland Strait coastline for waves approaching from more

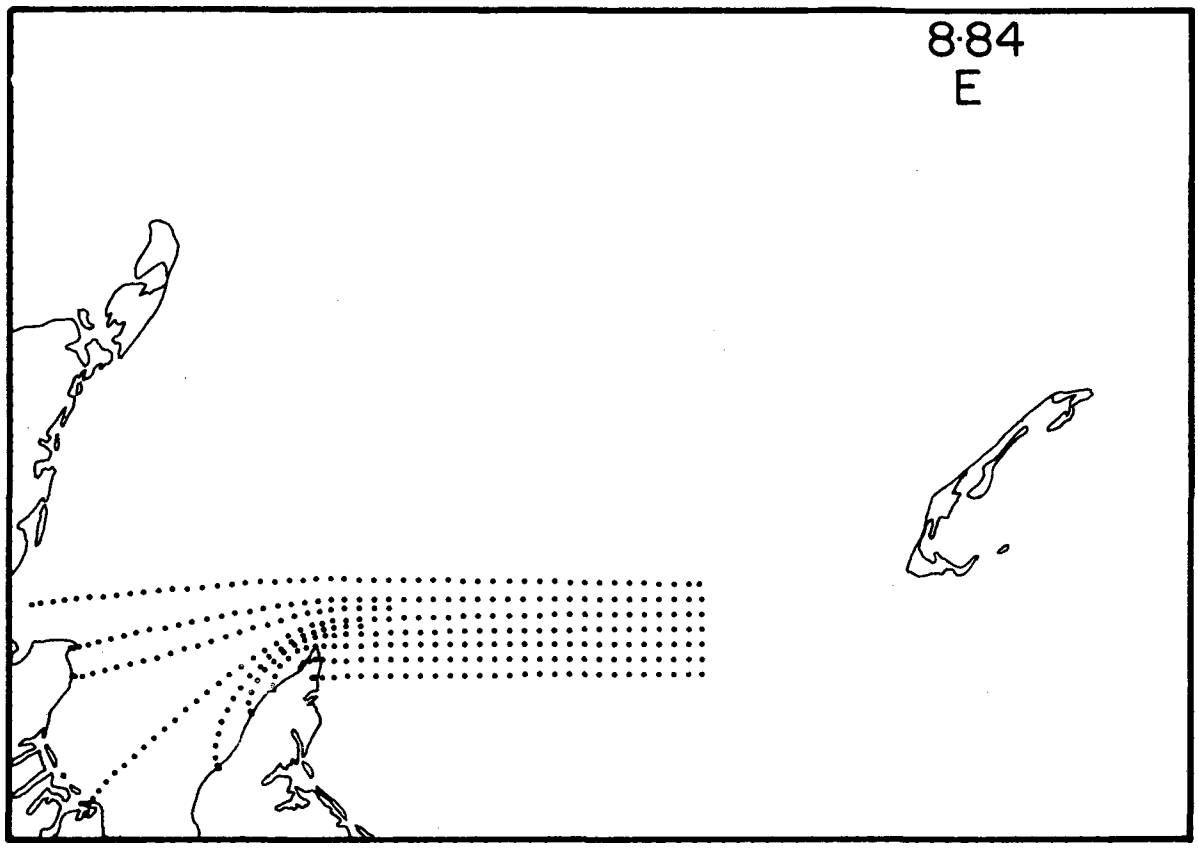

Figure 2 - Wave refraction diagram for 8.84 second waves from the east in the southern Gulf of St. Lawrence.

easterly directions. The most striking point on the refraction diagrams is the concentration of wave energy on the northwestern coast of Prince Edward Island. This concentration is greatest for large period waves and for waves approaching from the east (Fig. 2). Other areas of wave concentration are the north tip of Miscou Island, Point Sapin and Cape Richibucto - all locations with very rapid cliff erosion. Other details of coastal evolution such as rapid changes in barrier island disposition and the location and stability of inlets can be related to wave refraction patterns in detail which were revealed by the diagrams.

The above discussion of waves in the southern Gulf of St. Lawrence does not apply to the Northumberland Strait proper, which is protected by Prince Edward Island, and is an area of smaller waves. These shorter, steeper waves are sufficient to cause rapid erosion of the soft sandstong cliffs but the well developed barrier islands and spits of the more open coasts are absent.

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